Internal stress in the bright Sn coating was also measured using x-ray diffraction (XRD). In a XRD experiment, the change of the lattice constant due to the stress is measured. The stress can then be calculated from this measurement. The real-time analysis of stress evaluation during the aging can also be performed. The stress measurement results are summarized in Table 2. Measurements were performed both along the rolling direction as well as perpendicular to the rolling direction. As Table 2 demonstrates, both directions show virtually identical stress, indicating an isotropic biaxial stress in the Sn coating. No shear stress was observed on any samples. The as-plated bright Sn coating on Cu shows compressive stress of about 5 MPa. The same sample after aging for 15 months at room temperature shows a much higher compressive stress. The increase of the stress during the aging is most likely related to the intermetallic formation. The diffusion of Cu into the Sn coating occupies more space and generates compressive stress in the Sn-coating. The built-up of compressive stress during the aging explains the incubation time observed for the whisker growth on bright Sn. The presence of a Ni-underlayer minimizes or even eliminates the diffusion of Cu into Sn and Sn-Cu intermetallic formation. As a result of that, no compressive stress is observed on Sn/Ni/Cu. Instead, a tensile stress is observed for this sample. Consistent with this result, no whiskers are observed on these samples.

Table 2 Internal Stress measured by XRD

	Aging Time	Rolling Directions	Perpendicular to Rolling Directions
Sn/Cu	As plated	-4 ± 1 MPa	-5 ± 2 MPa
Sn/Cu	15 Months	-13 ± 2 MPa	-14 ± 1 MPa
Sn/Ni/Cu	3 months	14 ± 1 MPa	12 ± 1 MPa

It is to be understood that the above-described embodiments are illustrative of only a few of the many possible specific embodiments which can represent applications of the principles of the invention. Numerous and varied other arrangements can be readily devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A coated metal article comprising:

a metal substrate;

overlying the substrate a surface finish comprising a layer of tin or tin alloy being in a tensile stress state.

2. A coated metal article of claim 1 wherein the layer of tin or tin alloy has an average grain size in excess of about 1 micrometer.

3. A coated metal article of claim 1 wherein the average tensile stress is in excess of about 2 MPa.

4. The coated metal article of claim 1 further comprising an underlayer of nickel, nickel alloy, cobalt, cobalt alloy, iron or iron alloy chosen to generate or maintain tensile stress in the layer of tin or tin alloy above the underlayer.

5. The coated metal article of claim 1 wherein the tin or tin alloy layer has a thickness in the range 0.5 to 10 micrometers.

6. The coated metal article of claim 4 wherein the underlayer has a thickness in the range 0-20 micrometers.

7. A method of inspecting or monitoring an article having a coating of tin or tin alloy for tendency to grow tin whiskers comprising the steps of:

determining the internal stress in the coating; and

accepting or rejecting the article based on whether the internal stress comprises tensile stress exceeding a specified value.

8. The method of claim 7 wherein the internal stress is determined by using x-ray diffraction to measure the change in the lattice constant in the coating due to stress.

9. The method of claim 7 wherein articles with coatings having tensile stress in excess of about 2 MPa are accepted.

10. The method of claim 7 wherein articles with coatings having tensile stress in excess of about 3 MPa are accepted.